

**INTEGRATED ASSESSMENT METHOD FOR  
UNDERGROUND POWER CABLE PERFORMANCE**

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**B. ENG. (HONS.) MECHATRONICS ENGINEERING  
UNIVERSITI MALAYSIA PAHANG**

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**NG KEAT YONG**

Thesis submitted in partial fulfilment of the requirements for the award of B.Eng (Hons) of  
Mechatronics Engineering

Faculty of Manufacturing Engineering

**UNIVERSITI MALAYSIA PAHANG**

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## ABBREVIATIONS

**Cu** Copper

**IEC** International Electrotechnical Commission

**IEEE** Institute of Electrical and Electronics Engineers

**MSB** Main Switch Block

**SSB** Sub Switch Block

**PILC** Paper Insulated Lead Cable

**PVC** Polyvinyl chloride

**SWA** Steel wire armoured

**GUI** Graphical User Interface

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## ABSTRACT

The basic operation of any electrical machines that is catered to serve needs of civilization involves electrical power which is the main source to trigger the internal mechanism in the machines then transfer the power to other form of energy such as mechanical, light, sound and etc. The supplies of electrical does not happen just by providing the source itself, it has load carrying agent which in many cases, user would refer to it as cable. Specifically it is the power cable which its ampacity depends significantly on the operation temperature and load stress on it. Apart from having to focus on providing improvement on improving efficiency on the source itself, power cable plays an important role because without it, current ranging from low to high could not be transmitted and hence a failure of the power system generally. Studies have conducted to discuss whether which factor contributes relatively more to the causes of power cable failure or breakdown. Such factors can be narrowed down to the three major causes which are over temperature, over voltage and stress caused by over current. Over current is one of the factor which is depends on the usage of the power system itself. The higher the usage of the power system, higher the chances of over current to take place. This will then produce load stress on the cable which eventually destroy the insulator of the cable and slowly reach the core of the cable. It is believed that an assessment method should be implemented in order to predict the performance and failure rate of the power cable and use this prediction as reference rather than just letting power failure to happen anytime unpredictable which cause huge inconvenience to users and industries. Not only do a method should be implemented, it should be as easy to be used and understood by large range of users and integrated by a graphical user interface to be used. Therefore, this thesis will further narrow down on the approaches to do so and the location of studies involve MARDI Sdn Bhd which is an agriculture industries which has higher usage on their own underground power cable. Moreover, in the past history the company experienced electrical power failure and this studies and findings will definitely come in hand to provide them necessary help and benefits.

## ABSTRAK

Operasi asas mesin-mesin elektrik yang disediakan untuk memenuhi keperluan tamadun melibatkan kuasa elektrik yang merupakan sumber utama untuk mencetuskan mekanisme mesin kemudian memindahkan kuasa kepada bentuk tenaga yang lain seperti mekanikal, cahaya, bunyi dan lain-lain. Hasil bekalan elektrik bukan hanya dengan menyediakan sumber itu sendiri, ia mempunyai ejen yang mengangkut beban elektrik yang dalam banyak kes, pengguna akan merujuk kepadanya sebagai kabel kuasa. Khususnya ia adalah kabel kuasa yang kapasiti ampere bergantung dengan ketara kepada suhu operasi dan tekanan beban di atasnya. Selain daripada keperluan untuk fokus kepada penambahbaikan untuk meningkatkan kecekapan kepada sumber itu sendiri, kabel kuasa mempunyai peranan pentingnya kerana tanpanya, arus elektrik tidak dapat dihantar dan oleh itu kegagalan sistem kuasa berlaku secara amnya. Kajian telah dijalankan untuk membincangkan sama ada faktor mana yang banyak menyumbang kepada kegagalan kabel kuasa atau kerosakan kenderaan. Faktor-faktor tersebut boleh disimpulkan kepada tiga punca utama iaitu suhu yang tinggi, voltan dan arus elektrik yang tercecah maksimum menyebabkan tekanan ke atas kabel kuasa. Arus elektrik lebih adalah salah satu faktor yang bergantung kepada penggunaan sistem kuasa itu sendiri. Semakin tinggi penggunaan sistem kuasa, lebih tinggi peluang untuk menghasilkan arus yang lebih dan menghasilkan tekanan beban pada kabel yang akhirnya memusnahkan penebat kabel dan perlahan-lahan mencapai teras kabel. Kaedah penilaian perlu dilaksanakan untuk meramalkan prestasi kabel kuasa dan menggunakan ramalan ini sebagai rujukan dan bukan membiarkan kegagalan kuasa berlaku bila-bila masa yang tidak menentu dan membawa masalah yang besar kepada pengguna dan industri. Bukan sekadar mana-mana kaedah tetapi ia perlu juga berupa sebagai kaedah yang mudah untuk digunakan dan difahami oleh pelbagai pengguna dengan perlaksanaan dan mengintegrasikan ia dengan muka penggunaan grafik. Oleh itu, tesis ini lebih lanjut menyimpulkan pada cara untuk berbuat demikian dan lokasi kajian melibatkan MARDI Sdn Bhd yang merupakan industri pertanian yang mempunyai penggunaan kuasa yang tinggi pada kabel kuasa bawah tanah mereka sendiri. Syarikat tersebut pernah mengalami kegagalan kuasa elektrik. Kajian dan penemuan penyelidikan ini akan pasti memberikan mereka bantuan dan faedah yang perlu.

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 PROJECT BACKGROUND**

In the era of rapid growth of every field in the industries and as well as civilization, electricity power has become a necessity and it serves as the source for electrical machines operation which then helps to execute task which was desired for different purposes. Therefore the performance of power distribution is a significant aspect to be taken into studies and finding ways to enhance the performance. The general system of power distribution consist of a main power stations which transmit electrical currents to the other sub power stations and then directly to appliances locations such as factories, shop lots, households and etc. The electrical currents are transmitted through a load carrying cable which is capable to carry load with 500kV depending on the type of conductor of the cable itself.

During the early days of power distribution, overhead lines cable was the method to install those load carrying cable between power stations and appliances. Studies shows that overhead cable do come with few major disadvantages such as damage from severe weather conditions, constant relatively high electromagnetic field which causes power loss, geographically unfriendly to environment and disrupt aircraft or even wildlife. Therefore, undergrounding power cable method was then begun to be applied as early as in 1870 where there was a high demand and urgency for power cable to be installed in the urban and industrial areas so that every piece of lands in the country is a power supplied area.



Underground power cable was widely spread and used because of its major advantages that gives the maximized performance of a power distribution system. The electric magnetic field are comparatively lower than using overhead cable but it is depends on the depth of the cable being buried underground because those that buried lower due to insufficient space and rooms for the installation of power cable have similar amount of electric magnetic field produced. However, its advantages still outweigh the disadvantages because the disadvantages are mainly because of the cost, high maintenance and the inconveniences to fix the cable in case of power failure or any error occurred.

This led to many researchers to do study and come out with method to first analyze the load increase effect so that the power flow can be monitored and to make amendable changes to avoid any harm before it happens. However, it is found that all the methods are precise analysis using mathematical approaches and it can find out every characteristics at the instant of the power cable but it is does not come with a proper user-friendly system for front user to directly predict the future outcome of the performance of the cable depending on the frequency of usages or power dissipation. Overcurrent is one of the very main factor that damages the power cable internally which sometimes causes short circuit breakdown and permanent damage to the cable and this comes very unhandy for underground power cable where the installation takes much more complexity and time than overhead cable. Furthermore, overcurrent can lead to over temperature (overheat) which also damage the cable permanently. Lastly, overvoltage which is due to the over supplied voltage that the specified voltage of the cable can also damage the cable. However, preventives method have be implemented to lessen the chances of these factors such employing sensor to associate with the circuit so that the supply is disabled once it exceed the specific value and while associated circuits to disable the supply if its operating temperature exceeds a specific value. Overcurrent in this case still remains a quite high chances to happen compared to over temperature and over voltage because it is dependable on the output itself at the instant and the system cannot limit usage of power by the users, else it will become very unfriendly and large usage like factories can never be efficient.

Therefore, in this thesis, its purpose is to design an integrated assessment method for the underground power cable. This means it could be used by front user and directly enough for

them to understand their usages of power cable as well as performance in the time to come so that they can readjust their usages frequencies or maybe considering a round-up maintenance. Specifically, this studies of research will be carry out at location of MARDI (Malaysian Agriculture Research and Development Institute) Serdang, Selangor.

## **1.2 PROBLEM STATEMENTS**

It is ideal for an underground cable to be able to have high load carrying capacity and supply power efficiency and without extended outage. However, even though there is a means of effort to highlight about the limit of the power cable capacity, in other words its limitation, the frequency and capacity of usages is often hard to be controlled and monitored which then led to power breakdown or permanent damage to the cable. This is very relevant to our location of studies which is at MARDI Sdn. Bhd. (Malaysian Agriculture Research and Development Institute) because of the problem of circuit breakdown which led to delay in work progress and also cost spent on maintenance. Indeed, this is even relevant to most of the industries which has no proper method in assessing the power cable except the highly in depth and complicated analysis done by researchers which is difficult to put in practice by industries.

## **1.3 PROJECT OBJECTIVES**

The objectives of the project are:

1. To develop an integrated assessment method as monitoring system using MATLAB with Graphical User Interface.
2. To improve performance and sustainability analysis of underground power cable.
3. To predict the condition or performance of power cable in order to improve sustainability and practicality of underground power cable usage.

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